# High Fidelity Aeroelastic Shape Optimization of Wind Turbine Blades using Vertex Morphing Method

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## ABSTRACT

The latest developments of computational technologies regarding physical modelling, numerical mathematics, computer science and hardware make it possible to simulate coupled problems (e.g. Fluid-Structure Interaction) more accurately. The field of coupled simulations (especially fluid-structure interaction simulation) has received special interest from the wind turbine community in the recent years. As the turbines grow in size and the structural components of the turbine become more flexible and light weight, taking into account the interaction of the fluid and the structure in the design and analysis of the wind turbines becomes increasingly more important. In recent times, several researchers have published the result of their research on fluid-structure interaction simulation of wind turbines including [1] and [2]. The actual challenge is to further develop models and methods to deal with the optimization and the optimal control of coupled structures and systems due to their interaction with the environment. This paper presents the shape optimization of wind turbine blades in the context of a fluid-structure interaction simulation. Vertex Morphing method [3], [4], which is a node-based shape control technique, is used here to modify the geometry of the blades towards an optimal design. The Vertex Morphing method allows the full potential of node-based shape optimization to be exploited and to achieve optimal shapes which are not possible to get easily using other shape parametrization techniques. Gradient-based optimization together with continuous adjoint based shape sensitivity analysis is employed to handle the large number of design variables.

## REFERENCES

[1] S. Sicklinger, Ch. Lerch, R. Wüchner, K.-U. Bletzinger *Fully coupled co-simulation of a wind turbine emergency brake maneuver.* Journal of Wind Engineering and Industrial Aerodynamics, Vol. 144, (2015).

[2] M. Sayed, Th. Lutz, E. Krämer, Sh. Shayegan, A. Ghantasala, R. Wüchner, K.-U. Bletzinger *High fidelity CFD-CSD aeroelastic analysis of slender bladed horizontal-axis wind turbine.* Journal of Physics: Conference Series, Vol. 753, (2016).

[3] K.-U. Bletzinger *A consistent frame for sensitivity filtering and the vertex assigned morphing of optimal shape.* Structural and Multidisciplinary Optimization, Vol. 49, No. 6 (2014).

[4] M. Hojjat, E. Stavropoulou, K.-U. Bletzinger *The Vertex Morphing method for node-based shape optimization.* Computer Methods in Applied Mechanics and Engineering, Vol. 268, (2014).